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a complete knowledge of the life histories of all American frogs and toads. E. A. A.

Behavior of the Lower Organisms. By H. S. JENNINGS. New York, The Macmillan Co. 1906. Pp. xiv + 366; 144 figs.

This volume, which is the tenth in the series of biological treatises published by Columbia University, is a timely exposition of the behavior of the lower organisms by an author who has devoted a large part of his time to an investigation of this subject. The distribution of the materials in the volume follows an admirable plan. The first part of the book deals with the behavior of unicellular organisms, especially *Paramecium*. The second part takes up the behavior of the lower metazoans, including the coelenterates, echinoderms, worms and crustaceans. The third part treats of the theoretic aspect of the subject, and the volume is concluded by a bibliography and a good index.

The first and second parts, which are naturally more concerned with statements of facts than with speculative matters, are a very full and adequate description of the reactions of the protozoans, lower metazoans, etc., and form, in the reviewer's opinion, the best digest of this subject that has yet appeared. They entirely supersede such recent works as that of Lukas and others, and with their bibliographical references they form a most serviceable introduction to the subject.

The third part of the volume is much less happily conceived. This opens with a chapter in which the essential similarity of the reactions of unicellular and of multicellular animals is pointed out and the true relations of a nervous mechanism to these reactions is made clear, and it closes with chapters on the development of behavior and the relations of behavior to psychic factors, etc., avowedly hypothetical matters. The body of the third part, however, is taken up with a discussion which turns in the main on a comparison of the tropism theory and the author's own views about animal orientation, etc. It is possibly asking too much to expect an author to make a plea for the opposing side, and yet truth is

best served by looking facts squarely in the face. Almost no one nowadays, aside from Jennings, would accept the definition of the tropism theory given by him in Chapter XIV. To be sure, it is easy to find in the older literature the form of the theory that he describes, but practically every one at present who believes in the tropism theory at all has discarded as unessential that portion of it that asserts that the stimulus always influences directly the reacting organ. To retain this and demolish it in the belief that the tropism theory falls with it is rather Quixotic than clear-headed. If the modern tropism theory were as weak as Jennings would have us believe, the experimental evidence upon which it rests ought easily to be explained away. Yet it has always seemed to the reviewer that the characteristic circus movements performed by animals immersed in a homogeneous stimulant, but with sense organs unilaterally obstructed, are explainable only on the basis of this theory. There are other crucial observations in favor of the tropism theory and yet none of these have been satisfactorily accounted for by Jennings.

Jennings is perfectly correct in his insistence on the importance of what he formerly called the "motor reaction" as an explanation of the way in which many of the lower animals become distributed or massed, but to prove that this explanation holds in certain cases is not to disprove the tropism theory. The two theories are not mutually exclusive and the processes implied by them may perfectly well take place at the same time in a given animal. It would seem that Jennings in his enthusiasm for his own views had become blinded to the real strength of the tropism theory and not only was unable to accord it fair treatment, but also lacked appreciation of its real value. It is to be regretted that a book excellent in so many particulars should be marred by so considerable a defect.

G. H. P.

SCIENTIFIC JOURNALS AND ARTICLES

The American Naturalist for September contains articles on "The Structure of Cilia,